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DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

POSSIBLE ALTERNATIVES TO THE ROLLING THUNDER PROGRAM

(The Case of a Bombing Program that Includes the Mining of the Harbor Areas of Haiphong, Hon Gai, and Cam Pha.) (No. 12)

JCS review completed.

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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
May 1968

INTELLIGENCE MEMORANDUM

Possible Alternatives to the Rolling Thunder Program

(The Case of a Bombing Program that Includes the Mining of the Harbor Areas of Haiphong, Hon Gai, and Cam Pha.) (No. 12)

Summary

This memorandum analyzes the effects of a Rolling Thunder program that is carried on without the restrictions imposed on March 31 and includes the mining of North Vietnam's principal seaports. The campaign analysed assumes a sustained and intensive effort at interdiction of the key lines of communications connecting Hanoi with Communist China as well as attacks against the Haiphong port facilities.

A mining program would serve as an effective means of interdicting North Vietnam's normal seaborne commerce. The disruption to this trade would be widespread but temporary, given Communist China's cooperation. Within a short period -- two to three months -- North Vietnam and its allies would be able to implement alternative procedures for maintaining the flow of essential economic and military imports. Shipment of goods from the USSR and Eastern Europe by overland routes would raise costs and constitute a small additional burden on Hanoi's Communist allies.

Note: This memorandum was produced solely by CIA. It was prepared by the Office of Economic Research and was coordinated with the Office of Current Intelligence and the Director's Special Assistant for Vietnamese Affairs.

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There seems, in brief, to be no way of overcoming Hanoi's ability to sustain a continuing flow of essential material support from abroad, to distribute these goods internally, and to forward them to its forces in South Vietnam, except in the unlikely event of Chinese intransigence. The existing capacities of the railroad, highway, and river connections with Communist China -- some 14,500 tons a day -- are almost three times the daily volume of North Vietnamese imports. In addition, North Vietnam can resort to small coastal craft, lightering, and even airlift, if necessary, to maintain the flow of supplies. The experience of three years of bombing makes it clear that these alternative routes cannot be interdicted to the point that traffic would be cut below present levels.

A mining-bombing program would carry with it significant liabilities. The possibility of damage, sinking, or entrapment in port of foreign shipping is high. This would present the USSR, particularly, with difficult decisions and create new risks of a Soviet-US confrontation. If the mining were effective and forced a shift to alternate overland supply routes, it would require more extensive cooperation and assistance on the part of the Chinese. This conceivably could result in strengthening Chinese political influence in Hanoi at the expense of Soviet influence. We doubt, however, that any shift would be significant in terms of influencing Hanoi's war policy, since the North Vietnamese have tended, despite considerable dependence on China in the past, to set their own strategy and make their own decisions.

A mining program would also evoke protest and critical reaction from Free World maritime states. Almost all world powers would see the program as further intensification of the war, even if the program were to follow a breakdown of the Paris negotiation.

If the negotiations were in process when the mining program was started, Hanoi would probably

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break off the talks. However, any such North Vietnamese decision would probably be based on the total war situation, including the status of the fighting in the south and the success of the talks in undermining the position of the Saigon government.

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General

Mining the ports, coastal, and inland water ways of North Vietnam would result in the widespread disruption of normal seaborne transport. The intensity of this disruption and its duration would depend on the amount of warning time given and the extent of preparations that North Vietnam has made in anticipation of the mining. A number of foreign-flag ships might be caught in port and others en route would have to be diverted.* The North Vietnamese would have to quickly adopt alternative distribution procedures; reroute import traffic; reallocate small craft, rolling stock, and trucks; and reassign personnel.

An uncompensated loss of seaborne imports would be a serious threat to the North Vietnamese economy and war effort. Seaborne imports -- 1.4 million tons -- were about 80 percent of total imports in 1967. Imports of vehicles, machinery, generators, steel products, and petroleum have been essential to programs to repair domb damage and to maintaining the transport systems, while imports of foodstuffs and fertilizer have helped sustain the populace.

* *A mining program might catch a number of foreign-flag ships in the ports, although it is possible for mines to be equipped with delayed-action fuses to provide sufficient time for foreign-flag ships to clear the port. The average number of ships at Haiphong per day during the first quarter of 1968 included 22 freighters (7 Soviet, 2 Eastern European, 7 Free World, 5 Chinese Communist, and 1 Cuban) and 1 Soviet tanker. The actual number in port on any one day during this period ranged from 12 to 26 ships. One or two ships were loading coal at both Cam Pha and Hon Gai on any given day. In addition, an average of 8 to 14 ships can be expected to be at sea and to have declared for North Vietnam. These ships would either be diverted to Chinese ports, continue to North Vietnamese waters for lightering operations, or possibly even return to home ports, depending on contingency plans.*

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The North Vietnamese, however, could sustain the economy and the war effort at present levels for about two to three months solely by drawing down present reserves and maintaining present imports by rail. The high rate of imports during the past 18 months has probably permitted the accumulation of reserve supplies of petroleum, metals, construction materials, and transport equipment. Imports of foodstuffs during 1967 totaled almost 450,000 tons and have been at a higher monthly rate thus far in 1968. This level of imports exceeds the estimated crop shortfalls during the last 18 months and suggests that food reserves on hand are adequate for several months of consumption.

By the end of three months, the North Vietnamese could have taken the necessary countermeasures to the mining program by rerouting essential seaborne traffic to one or more of the many alternative transportation routes. Two rail and eight highway routes connect Hanoi with Communist China. The upper reaches of the Red River from China provide another route that can carry many kinds of imports. These land alternatives were used to less than 10 percent of their capacity during 1967 and are being used even less at present. Shallow-draft lighters could be used to unload cargo from oceangoing ships anchored in waters outside the mined areas. Large numbers of coastal ships and junks could move cargoes from ships diverted to the southern Chinese ports of Fort Bayard, Canton, or Peihai and unload in ports, over the beaches, or move into North Vietnam's network of inland waterways. An airlift from Chinese airfields to Gia Lam, which handles international traffic and has not yet been struck by air attacks, could potentially provide a means for importing a large volume of high-priority goods. Imports formerly received by sea could move by rail all the way from the USSR and Eastern Europe or they could be transshipped from South China ports without placing a noticeable strain on either the Soviet or Chinese rail systems. Two trains (of 35 freight cars each) arriving each day from China could carry the entire volume of Soviet and Eastern European seaborne goods imported by North Vietnam in 1967. For selected transportation facilities in North Vietnam and South China, see the map.

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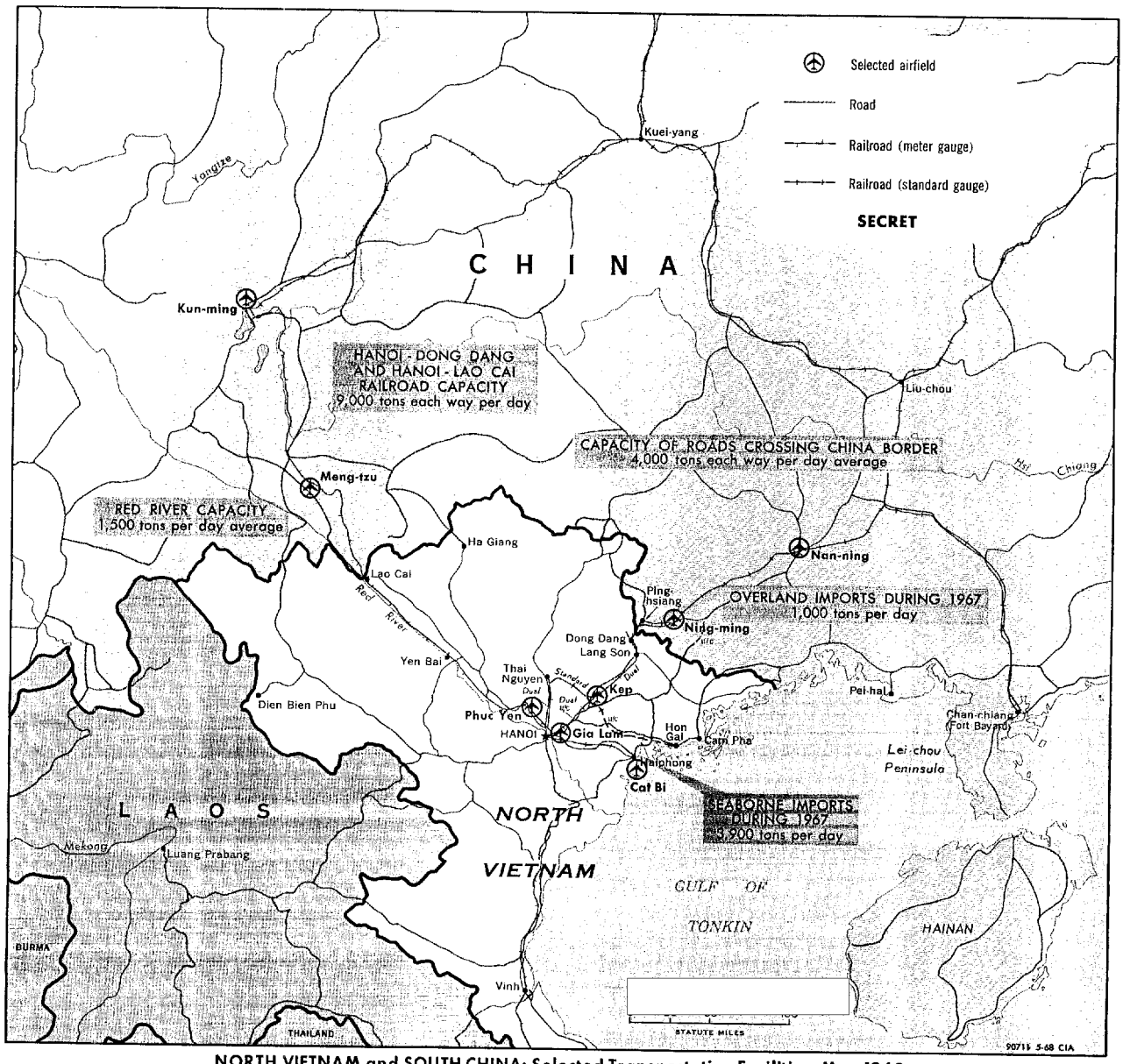

NORTH VIETNAM and SOUTH CHINA: Selected Transportation Facilities, May 1968

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All of the countermeasures to a US mining program, except for direct lightering from ships to the shore, would require the cooperation of the Chinese. If all Soviet and East European seaborne shipments were diverted to an overland route via the Trans-Siberian railroad, the Chinese would have to permit a sixfold increase over the 1967 volume of Soviet and East European traffic transiting China. Using Fort Bayard, for example, would require a willingness on the part of the Chinese to transship cargo by rail 668 kilometers from Fort Bayard to P'ing-hsiang. The Chinese would probably be reluctant to emphasize the importance of Soviet aid to North Vietnam by cooperating in this manner. However, faced with the alternative that the North Vietnamese could not continue the conflict without major infusions of Soviet and East European aid, the Chinese would probably be forced to help maintain the flow regardless of the nationality of the donors.

Levels of Import Traffic

During 1967 North Vietnamese imports reached record levels totaling almost 1.8 million tons as shown in the following tabulation:

	Metric Tons	
Economic goods	Annual	Daily
Bulk foods	447,000	
Fertilizers	147,000	
POL	256,000	
Miscellaneous	809,000	
	1,659,000	4,600
Military goods	125,000	300
Total imports	*1,784,000*	*4,900*

During the first four months of 1968 imports have been at levels 10 to 15 percent higher than in the corresponding period of 1967. Most of this increase has been in imports of foodstuffs and petroleum.

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The volume of imports maintained by North Vietnam has been in excess of the current best estimates of consumption patterns and requirements. Part of the surplus may be to compensate for disruptions to production or to distribution and storage systems. On the other hand, it is likely that this high level of imports reflects an element of contingency planning by Hanoi to build up reserves and stockpiles in the event that the port of Haiphong is closed.

The importance of Haiphong is apparent in the fact that seaborne imports during 1967 averaged 3,900 tons a day, or about 80 percent of North Vietnam's total imports. Thus if the use of Haiphong were denied, North Vietnam could possibly be required to move almost five times as much cargo over its existing land transport connections with Communist China. The added burden on the land transport connections could be reduced to the extent that North Vietnam is able to cut back on its total import requirements. On the other hand, North Vietnam should be able to transfer some part of the import burden to other means of transport such as coastal shipping, lighters, and air transport.

Land Route Capacities and Import Requirements

The daily capacity of the railroad, road, and water routes from China to the Hanoi area of North Vietnam totals 14,500 tons and far exceeds the daily tonnage requirements needed even if all seaborne imports were shifted to land routes (see Table 1).

The high volume 1967 import program would exceed the capacity of the existing road and inland water systems and could conceivably exceed the interdicted capacity of the railroads. When the land transport routes are viewed as a single system, however, the combined capacity is almost three times greater than traffic requirements.

While there would be initial delays and confusion, the North Vietnamese would be able to obtain, deploy, and operate the required number of trucks, railroad rolling stock, and water craft to shift all of their seaborne imports to land lines of communication. The North Vietnamese would probably

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Table 1

Comparison of Import Requirements
to Capacities of Lines of Communication

	Tons per Day	Imports as a Percent of Capacity
Actual 1967 imports	4,900	
Capacities		
Total surface lines of communication	14,500	34
Railroads a/	9,000	54
Roads	4,000	122
Red River	1,500	327

a. These are uninterdicted capacities. Although the Hanoi-Lao Cai line is given a current capacity of 700 tons a day, its normal capacity of 3,000 tons a day is used here. It is assumed that the alternate facilities that give a capacity of 700 tons a day at the Viet Tri interdiction point are more than adequate to meet current small traffic requirements. For the purpose of this memorandum, it is assumed that if a higher traffic requirement existed, the North Vietnamese would raise capacity to whatever level was necessary. Moreover it is estimated, on the basis of their demonstrated capability, that the necessary alternate crossings could be established and in operation within three months.

receive additional logistical support from the Chinese in terms of rolling stock, engineering troops, and transport specialists. To move the entire volume of 1967 imports -- 4,900 tons a day -- by rail from P'ing-hsiang to Hanoi would require the employment of about 300 standard gauge freight cars in about seven trains arriving daily, without even using the roads or Red River to move a portion of the traffic. The roads and Red River have a combined capacity of 5,500 tons a day. This provides a cushion that is more than adequate to accommodate whatever volume of traffic cannot be moved by rail.

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Water and Air Alternatives

North Vietnam can use other alternatives to maintain its import traffic and thus avoid complete reliance on its overland transport connections. These alternatives include lightering of oceangoing ships outside mined areas, the use of coastal shipping from China, and the use of air transport.

In the case of lighters and coastal craft, North Vietnam has adequate inventories to move import traffic even at the higher levels of 1967. As a practical matter the use of these water alternatives would probably be limited. The off-loading of some types of cargo -- bulky machinery and transport equipment -- would be difficult. Also in the face of air attacks and a widespread use of the MK-36 mine, it is possible that cargo losses might be too heavy to warrant sustained use of lighters or coastal shipping. They could, however, be used sufficiently to be a significant means of easing pressures on overland transport routes.

The use of air transport would probably be limited to the import of high-value or urgently needed imports. An air transport program would be almost wholly dependent on Soviet and Chinese assistance. Because the Chinese could not provide the aircraft necessary to sustain a large airlift without disrupting air transport in China, the USSR would have to furnish the aircraft to sustain such an operation. The Soviet military inventory of high-performance transport aircraft as of 1 January 1967 included about 640 AN-12's designed for short take-offs and landings on unimproved runways. About 100 AN-12's could provide an airlift between South China and North Vietnam at the 1967 import rate of 4,900 tons a day.

The Chinese would have to permit the Soviets to transit Chinese territory to a much greater extent than they have thus far and permit Soviet personnel, aircraft, and maintenance facilities on Chinese airfields. Because an airlift would not be required to move all imports, it is doubtful that the Chinese would make such concessions. Furthermore, the

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Soviets themselves would probably not be willing to risk the escalation of the war which might occur if Soviet aircraft were destroyed during US air attacks on North Vietnamese airfields.

The Experience of Past Interdiction Campaigns

An air campaign aginst the northern lines of communication in circumstances when they are required to carry all of North Vietnam's imports should achieve greater interdiction of supplies than any US effort to date. Target density -- in terms of traffic volume -- would be about five times that which moved over these lines during June-August 1967, the high point of past US interdiction efforts. It is probable that the railroads alone could not bring in the 1967 volume of imports if they were kept under sustained air attack. The 1967 volume of imports would require slightly more than one-half of total rail capacity, and an intensive and sustained air interdiction program may have a good chance of reducing rail capacity by more than this amount.

However, on the basis of all the modes of transportation that are available to the North Vietnamese, an air interdiction effort against the lines of communication from the China border is not likely to be successful. Air attacks would have to overcome the same problem that has previously hampered such efforts -- the combined capacities of the routes greatly exceed the requirements for traffic. Even a highly successful air interdiction campaign against railroads could not be expected to reduce their capacity to the level necessary to impede the flow of essential economic and military goods. The capacities of roads and waterways would supply an additional cushion or guarantee that adequate capacity was available.

Results of the June-August 1967 air interdiction campaign, the heaviest of the war so far, support the contention that an interdiction effort, even against a heavier concentration of targets, will not exact a prohibitive cost from the enemy or "succeed" where earlier efforts have failed. The

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heavy attacks during the June-August period damaged bridges, interdicted roads and rail yards, and forced the Vietnamese to use elaborate time-consuming and labor-consuming bypass systems that consisted of alternate semipermanent bridges, pontoon bridges, causeways, and motor truck and railroad car ferries. Nevertheless, the North Vietnamese transport system was still able to function effectively.

Strikes in August against the Hanoi-Dong Dang rail line -- the rail line most used for import traffic from China, the USSR, and East Europe -- were effective in stopping through service for a total of only ten days. It was not possible to interdict through traffic for a longer period of time mainly because each bridge attacked had one or more bypass bridges available. Photography taken throughout the period indicates that several yards were sometimes unserviceable for through rail service after they were struck but had at least one through track open for traffic within a short time.

Strikes against the three highways which generally run parallel to the Dong Dang line and can serve as alternates for the rail line -- Highway Route 1A and two other highways from Mong Cai and Cao Bang -- were probably even less effective. Observed countermeasures indicate that no significant or sustained reduction of capacity was made.

Strikes against the Hanoi-Lao Cai rail line -- the other rail line used for import traffic from China, the USSR, and Eastern Europe -- did not reduce the capacity of the line below the 700 tons achieved by the destruction of the Viet Tri bridge in 1966. The line's capacity of 700 tons was maintained by a rail car ferry at the site of the still unrepaired Viet Tri bridge. If more capacity had been required, there is every reason to believe that additional facilities would have been installed at this location to restore the through capacity of the line.

Strikes against the two highway routes that parallel the Lao Cai rail line were equally ineffective. Highway traffic around the destroyed bridge at Viet Tri was moved throughout the June-August period by

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ferries, a pontoon bridge, and in part by a cable bridge. Damage to other highway bridges attacked on the two routes was not significant; structures were quickly repaired or bypassed.

Prospects for Interdiction of Alternative Routes

An air interdiction campaign against North Vietnam's lines of communication in conjunction with a mining program must allocate the total number of sorties available to a conventional mining program against oceangoing shipping; the MK-36 mining program; strikes against fixed targets such as bridges, ferries, rail lines and highways; and strikes against fleeting targets -- railroad rolling stock, trucks, and watercraft.

The essential problem is to reduce the capacity of 14,500 tons per day that is avaiable to the North Vietnamese for moving supplies south from China to a level that puts a meaningful ceiling on traffic flows. This objective requires interdiction of facilities or equipment to a much greater extent than has been achieved thus far in the air war. Three years of air war in North Vietnam have shown -- as did the Korean War -- that, although airstrikes against rail and road segments will destroy transport facilities, equipment, and supplies, they cannot successfully interdict the flow of supplies, because so much of the damage can frequently be repaired within hours.

The complexity of the interdiction effort is apparent in the multitude of targets that must be kept under attack. North Vietnam, for example, has 650 permanent bridges on the principal lines of communication that could be used to circumvent the mining of Haiphong. If all of these permanent bridges were provided with alternate crossings to the same extent as the bridges on the vital Hanoi-Dong Dang line, there could be as many as 2,000 fixed transport targets. In addition, the North Vietnam logistics target system includes large numbers of transport vehicles that must be neutralized. North Vietnam could commit to its resupply programs an estimated 120 locomotives, 2,000 to 2,300 freight cars, 11,000 motor trucks,

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and more than 30,000 water craft. Only a small share of these vehicles would be required to maintain import programs at 1967 levels.

From June through August 1967 the lines of communication in North Vietnam were subjected to the heaviest scale of attack achieved to date. On the basis of an assumed 50 percent increase in the scale of the attack (from an average of 285 to 425 sorties a day) and damage effects similar to those achieved to date, the prospects for an escalated interdiction campaign can be estimated. The results, summarized in Table 2, show clearly that even this heightened campaign offers little promise of reducing the flow of supplies significantly.

If this campaign were flown exclusively against fixed targets, hits against facilities such as bridges or alternate crossings would range from 24 to 47 a day, depending on the ordnance mix. If the attack were flown solely against fleeting targets, it is estimated that 75 vehicles a day would be effectively destroyed. In either case, or in any combination of attacks, it is probable that weather and operational problems would make it impossible to maintain this extent of damage on a daily basis.

The frequency with which bridges and bypasses could be kept under attack would obviously be less than the time required to offset damage effects. On the basis of past effectiveness of North Vietnamese countermeasures, an interval as short as two to four days would be more than enough to repair the bomb damage done to the majority of the specific facilities or to institute substitute means of continuing traffic.

In 1967, only the attacks against the key Doumer, Canal des Rapides and Haiphong bridges required a repair time in excess of 30 days. In all three of these cases, however, the North Vietnamese have built numerous high-capacity bypasses that have been more than adequate to keep traffic moving. Numerous other examples exist to show that even heavily damaged bridges were repaird within a few days of being hit. When two 53-foot spans were dropped at the Bac Giang Railroad/Highway Bridge on

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30 April 1967, the Vietnamese and Chinese had it repaired and serviceable one day later. The isolated and intermittent cuts that can be expected along the various lines of communication would not be sufficient to seriously impede the flow of supplies.

The maximum attack against fleeting targets could be expected to deplete the inventory of freight cars and motor trucks* committed to import operations within four or five months. This prospect is lessened by several factors:

1. Inventories of transport equipment could be maintained through increased imports. The Chinese inventory of standard gauge railroad cars would be available to move essential supplies from China to the Hanoi area. Imports of trucks would have to increase substantially, but total imports would not have to exceed 1,800 per month.**

2. It is doubtful that previous kill ratios -- heavily weighted by operations in the panhandle of North Vietnam where antiaircraft fire is much less than over Route Package VI -- can be maintained.

** It is assumed that, because of priority uses in North Vietnam and Laos, only one-half of the total inventory of motor trucks, or some 5,500 vehicles, could be allocated to the import operation.*

*** This would not be an impossible drain on Communist truck production. During the Korean War, the enemy was estimated to have had 8,500 vehicles in operation. Some 48,000 were destroyed and damaged during an eleven-month perid by the US Air Force alone. The operable inventory of vehicles, therefore, was replaced or rebuilt more than five and one-half times during this period if the Air Force claims were accurate. To maintain the operable inventory of 8,500 during the eleven-month period, about 4,400 vehicles would have had to be imported or restored each month, more than double the monthly vehicle kills of 1,800 estimated for North Vietnam under the assumed escalation of the airstrikes.*

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3. Furthermore, the experience of the air war has shown that, because of bad weather, intensive attacks against lines of communication cannot be maintained over long periods of time. For example, during July 1967 a daily average of 120 attack sorties were directed against targets in Route Package VI. In December 1967, bad weather reduced this average to only 27 attack sorties.

Both of the damage effects discussed in this section represent maximum results from a concentration of the attack on either fixed facilities or fleeting targets. The effects of a mixed target program would be between the extremes discussed here. Whatever the mix of targets, it is apparent, however, that the attacks contemplated in this section -- up to 50 percent greater than those accomplished so far against the lines of communication -- would create widespread problems for the North Vietnamese and there would be a much higher rate of destruction of transport equipment and cargoes than has been achieved thus far during the air war. It is probable that for certain periods of time -- days or even weeks -- the North Vietnamese could not move the total volume of 1967 imports, 4,900 tons a day. Over the longer pull, it seems certain, however, that by using all facilities available to them, and by receiving additional aid, the total volume of military and economic goods necessary to continuing the war could be maintained.

Targets in the Haiphong Port Area

There are a number of targets in the Haiphong port complex that could be included in a complete interdiction campaign. These targets include:

JCS Number		Facility
25X1		Haiphong Docks (Area E) 25X5
		Haiphong Naval Base (Area D)
		Haiphong Shipyard 3 (Area B)
		Haiphong Shipyard 1 (Area F)
		Haiphong Shipyard North (Area G)
		Haiphong Railroad Yard Shops

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JCS Number	Facility
	Haiphong Warehouse Area, Port
	Haiphong Warehouse Area
25X1	Haiphong Shipyard Vinh
	Don Nghia POL Tank Fabrication
	Haiphong Shipyard Central
	Haiphong Air Defense Center
	Haiphong Open Storage Mall
	Haiphong Storage 5
	Haiphong Open Storage
	Haiphong Storage 2

The attacks would compound distribution and storage problems and deprive Hanoi of a valuable sanctuary, and initial attacks might destroy large quantities of stockpiled supplies. Many of these targets, however, would lose their lucrative character after the first attacks. The open storage and warehouse areas, particularly, would not be used after attacks against this area. Stockpiles would be moved to dispersed storage areas, and little new materiel would be entering Haiphong during a mining campaign.

The effects of successful attacks on port and shipyard facilities might have some immediate significance, but these effects would be short-lived for several reasons. The shipyards taken under attack contribute a relatively small percent of total North Vietnamese shipbuilding and ship repairs capability. These yards are engaged principally in building and repair of small craft and barges. This type of activity is easily transferred to other locations, and the production that is lost can be replaced by new imports or transfers of Chinese small craft and barges. More to the point, a complete cessation or sharp decrease in seagoing commerce resulting from a mining program would mean that these facilities would fall into disuse as imports are transferred to alternative routes. The use of such alternatives as lightering and coastal shipping generally would not require the use of Haiphong port facilities.

All of the targets listed are located within a radius of 1.5 miles from the center of Haiphong. They are located in formerly prohibited zones that

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are built up and heavily populated. It would be almost impossible for air operations to avoid spilling over into areas where civilian casualties would be at high rates.

Finally, these targets are located in one of the most heavily defended areas of North Vietnam. The experience of previous campaigns shows that attacks against targets in the immediate areas of Hanoi and Haiphong have resulted in loss rates for US aircraft from seven to eight times greater than the rate for operations over all of North Vietnam.

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Table 2

Hypothetical Escalated Attacks Against
the Northern LOC's in North Vietnam

Scale and Weight of Attack		Targets	
	Average Sorties per Day		Number
June-August 1967	285 a/	Fixed targets	
Assumed escalation	425 b/	Permanent railroad bridges	141
Allocation of sorties sorties		Permanent highway bridges	500 +
MK-36 program	40 c/	*Total permanent bridges*	*650*
Other targets	385	Total potential fixed transport targets	2,000 d/
Estimated Effects		Mobile targets	
	Total per Day	Locomotives	120
Hits on fixed facilities	24 to 47 e/	Freight cars	2,300
		Motor trucks	11,000
Mobile targets destroyed	76 f/	Junks, sampans, and barges	30,000 +

a. Average against all lines of communication (rail and highway) in North Vietnam.
b. An increase of about 50 percent above the June-August 1967 rate concentrated against northern lines of communication only.
c. The MK-36 program calls for 13,000 weapons to be delivered per month by mid-1968, which would require an average of 40 sorties per day. About 385 sorties would therefore be available for delivering standard ordnance -- about 1.7 tons per sortie -- the rate at which it was dropped during attacks on the lines of communication during June-August 1967. For the purpose of this illustration, it is assumed that most of the MK-36's will have to be used to attempt to halt lightering operations.

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Table 2

Hypothetical Escalated Attacks Against
the Northern LOC's in North Vietnam
(Continued)

d. Total permanent bridges plus improvised alternate facilities extrapolated at the rate that they exist on Yen Vien - Dong Dang line.
e. A case study of the attack on 48 JCS-targeted bridges in North Vietnam during the period February 1965 through December 1966 reveals that on the average one hit was scored for every 47 bombs dropped. Using this experience, 550 tons of conventional ordnance has a good probability of providing 47 hits with 500 pound bombs, or one-half that number with 1,000 pound bombs. A hit was defined as causing the collapse of one or more spans or causing structual damage to piers or abutments.
f. During 1967, it is estimated that there was one effective loss to a vehicle (locomotive, freight car, motor truck, or watercraft) per 5.1 armed reconnaissance sorties flown. Therefore, 385 sorties per day would destroy about 75 vehicles.

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